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RECOVERY POTENTIAL ASSESSMENT FOR UMATILLA DACE (*RHINICHTHYS UMATILLA*) IN BRITISH COLUMBIA

Figure 1. Umatilla Dace (illustration by D.L. McPhail, from McPhail 2007, used with permission from J.D. McPhail).

Figure 2. Global range of Umatilla dace (adapted from COSEWIC 2010)

Context :

Recovery Potential Assessments (RPA) were established by the Fisheries and Oceans Canada to: assess the biological basis for survival or recovery of the species, advise incidental harm permitting, support subsequent socio-economic analyses, support future recovery planning, and to advise the Minister on listing decisions. The RPA for Umatilla dace was prepared according to revised guidelines that stress a species' ability to recover from known human activities within the uncertainties posed by limited data (DFO 2007).

*Dace are minnows belonging to the Order Cypriniformes. Adult Umatilla dace (*Rhinichthys umatilla*) are usually under 10 cm in fork length, with morphology intermediate between that of speckled and leopard dace, implying that Umatilla dace is the result of hybridization between the other two species. The Umatilla dace in Canada are found at the upper limits of their global distribution and the Canadian distribution represents only 5% of the total global distribution. In Canada, the species' occurrence is limited to the Similkameen River, Tulameen River, Columbia River below the Hugh Keenleyside Dam, Kootenay River below Bonnington Falls, lower Slocan River, lower Pend d'Oreille River, and the Kettle River below Cascade Falls.*

There have been few directed surveys for Umatilla dace for most of their Canadian range within the past 20 years (around five generations), few estimates of abundance, major gaps in our understanding of habitat use are evident, and very little specific information on Umatilla dace behaviour. Considerable difficulty in differentiating Umatilla dace from related dace during surveys complicates existing historic data collections. Thus, there is great uncertainty around the persistence of the species in some watersheds and population projections or targets are impossible to estimate. Recruitment is known to have occurred within The Similkameen and Columbia Rivers. Threats to Umatilla dace in the Canadian portion of its global range include; hydroelectric development, flow changes related to existing dam operations, introductions of alien species, water extraction, resource extraction, land use (agriculture, transportation corridors, timber harvest) and scientific over-sampling.

Canada

SUMMARY

- Umatilla dace was designated Special Concern by COSEWIC in 1988, and was included on Schedule 3 of the Species at Risk Act (SARA) in 2004. In April 2010, the species was assessed as Threatened by COSEWIC based on the limited area of occupancy, <10 locations, and the expected future loss of habitat or deterioration of habitat quality due to potential threats.
- Major gaps in our knowledge are evident. There are considerable difficulties in species identification; sampling methods for specific life stages over a range of habitats are suspect and inconsistent over time. Current distribution is uncertain as there have been no surveys for Umatilla dace within most of their historic range within the past 20 years. Few estimates of abundance exist and these are confined to a few locations in one watershed. Thus distribution targets are impossible to estimate.
- Although recruitment is known to have occurred in the Columbia and Similkameen Rivers, there is great uncertainty around the persistence of the species in some watersheds and population projections or targets are impossible to estimate.
- Potential critical habitats could be described as riverine, higher velocity, silt free water, with coarse gravel-cobble-boulder substrates bordering confirmed Umatilla dace sites.
- Allowable harm to Umatilla dace in all systems should include scientific sampling for the purpose of further understanding abundance and habitat use of the species, but total harm should not increase beyond current levels.
- Umatilla dace spawning has never been observed in the wild, but if nest site preparation by males does occur, it implies a residence requirement for spawning.
- A recovery goal could be considered as maintaining current abundance, distribution, and number of existing locations. A more aggressive goal would require addressing uncertainties as to the number of locations, projected rate of habitat loss and habitat quality, and quantification of threats.
- Umatilla dace was assessed as threatened based on the potential of future threats to reduce quality and quantity of habitat, thus it is likely that current quantity and quality of habitat is sufficient to recover the species if those threats do not occur.
- Threats to dace include; hydroelectric operations and dam development, alien invasive species, low seasonal water levels associated with water withdrawals and climatic changes, resource extraction, logging and mountain pine beetle deforestation, and removal of dace for scientific research purposes.
- Extensive surveys are recommended to confirm the distribution (including number of locations), abundance, and habitat types utilized by Umatilla dace. Studies on the impacts of rapid flow changes should continue. The utility of targeted angling on invasive species could be examined.

BACKGROUND

Species Biology

Dace are minnows belonging to the Order Cypriniformes, a large group that dominates the freshwater fish fauna. Adult Umatilla dace are usually under 10 cm in fork length (Figure 1).

Four species of dace co-exist within the known range of Umatilla dace in Canada. Umatilla dace coexists with longnose dace (*Rhinichthys cataractae*) throughout its range, leopard dace (*R. falcatus)* in the Columbia, Kootenay and Similkameen Rivers, and speckled dace (*R. osculus),* in a short section of the Kettle River below Cascades Falls in British Columbia.

Wild spawning has not been observed in Umatilla dace, although some inferences can be drawn from speckled dace and from laboratory studies (McPhail 2007). McPhail (2007) concluded that Umatilla dace spawned in July or early August by releasing and scattering adhesive eggs over cobble substrate. The eggs hatched after 6 days (at 18°C), resulted in 7mm fry, spent a week or so in gravel before emerging to feed on exogenous sources, and grew to less than 30 mm during the first growing season. Sparse data on food and feeding suggest that Umatilla dace adults and juveniles feed mainly on aquatic insect larvae, especially chironomids while periphyton and detritus may also be consumed in winter.

ASSESSMENT

Current species status

Range and number of populations

The Umatilla dace in Canada are found at the upper limits of their global distribution, and the Canadian distribution represents only 5% of the total global distribution (Figure 2). Species' occurrence is limited to the Similkameen and Tulameen Rivers, the Columbia River below the Hugh Keenleyside Dam, the Kootenay River below Bonnington Falls, the lower Slocan River, the lower Pend d'Oreille River, and the Kettle River below Cascade Falls. There have not been comprehensive surveys for Umatilla dace over much of the dace's range within the past 20 years. Within the species' Canadian range, the largest stretch of relatively unaltered habitat is found in the Similkameen River. The species appears to have been extirpated from Otter Creek (a tributary of the Tulameen) and it may also no longer exist in the Pend d'Oreille River as only one individual was ever found.

Abundance

There is uncertainty concerning the abundance of Umatilla dace as distribution data has been collected using various methods. There have been no targeted population counts for Umatilla dace in the Kettle, Similkameen, or Pend d'Oreille Rivers, and COSEWIC (2010) considered the Otter Creek population extirpated. The few abundance estimates (mainly in the main stream Columbia River) are compromised by problems with species identification, inability to adequately sample deeper riverine habitats, and the reliance on daytime sampling (Umatilla dace may be nocturnal).

The species is considered rare in the Similkameen watershed and McPhail (2007) considered the Similkameen form to be "in trouble". McPhail (2007) felt Umatilla dace were "locally abundant" in the Columbia, Kootenay and Slocan Rivers. What knowledge we have of their abundance comes from sampling related to impact assessments for new hydroelectric facilities and water use plans for existing dams. The stretches of river below the Hugh Keenleyside Dam (Columbia

River) and the Brilliant Dam (Kootenay River) have consistently provided the highest densities of Umatilla dace in their Canadian range (1.2 fish/m^2 and 1.3 fish/m^2 respectively; R.L. and L. 1995).

Recent Species Trajectory

COSEWIC (2010) noted dace populations "do not appear" to have declined (are considered to be stable); with the exception of Otter Creek (where they were presumed to have been extirpated) and the Pend d'Oreille River (where only one Umatilla dace was ever found). COSEWIC (2010) concluded that recruitment appears to have been successful because the species has repeatedly been caught in most locations where it had previously been found. It is impossible to develop meaningful numerical population trajectories from the few estimates of abundance, as it is difficult to compare the different sampling efforts and varied methods employed.

Life History Parameters

There is very limited information available on life history parameters (mortality, fecundity, age at maturity, longevity and recruitment) specific to Umatilla dace. Some of these parameters might be inferred from similar species. Although recruitment is known to have occurred in the Columbia and Similkameen Rivers, the persistence of the species in the other watersheds (i.e. Kettle and Pend d'Orielle) has not been confirmed. McPhail (2007) crudely estimated fecundity at up to 2,000 eggs per female. Scott and Crossman (1973) make the generalization that most dace species live three or four years; the oldest Umatilla dace recorded from its Canadian range was a female in its sixth summer (McPhail 2007). Survival at the various life stages is unknown; this knowledge gap makes it hard to estimate recruitment and adds to the challenge of predicting allowable harm.

Habitat Requirements, Habitat Use Patterns and Potential Critical Habitat

The general habitat requirements of Umatilla dace can be inferred based on the limited information specific to Umatilla dace, plus knowledge from related dace species. For reproduction, it has been suggested they use riffle areas associated with pools. Juveniles and fry have been found in shallower, near shore areas, including those with sand and silt substrate. Because fry and early juveniles appear to use shallower water, these stages would be expected to be most vulnerable to stranding.

Umatilla dace were most often captured over substrates with large gravels to boulders and selected the slow-water refugia (0-5 cm/sec) within faster-flowing streams. Feeding adults used glide habitat with bank slopes less than 15%. In summer and autumn, the lack of larger individuals obtained from shallow sampling studies in the Kootenay River suggests the older individuals moved into deeper water habitat for feeding and holding in the winter. Because non-destructive sampling in deeper areas is near-impossible, the usage of deeper, swifter water by older age-classes (larger fish) can only be inferred. Umatilla dace move to deeper water at night. Partitioning between shallow and deeper areas is another data gap that needs to be addressed in field studies. Although Umatilla dace appear to exhibit diurnal and seasonal habitat shifts and move from near-shore areas to faster, deeper waters as they grow (COSEWIC 2010), the requirement for coarse habitats with interstitial spaces between the rocks may limit their distribution and abundance and thus may be considered as necessary for survival and recovery. Potential critical habitats could be described as those riverine habitats with the above physical characteristics bordering confirmed Umatilla dace sites.

The species was observed in the Brilliant and South Slocan reservoirs (Hughes and Peden 1989), although later reservoir sampling failed to find any. Peden (1991) mentions the occurrence of Umatilla dace in the Kootenay River Reservoir between the Brilliant and South Slocan dams. He noted that the numbers appeared to be low (based on sampling effort), and

occurrence may be confined to upper reaches of the reservoir where there is some water flow as a result of frequent discharges for electricity generation.

Population and Distribution Targets

There is a lack of population census data for Umatilla dace and much of their potential habitat has not been surveyed. Trends in abundance are often anecdotal and at best qualitative as a variety of sampling methods and sampling conditions have been used. While at least two populations appear to have been extirpated, setting a numerical target for those that remain is impossible.

Residence Requirements

Umatilla dace are assumed to be broadcast spawners whose adhesive eggs are not guarded. Thus, at first glance it appears the Umatilla dace does not require a residence. However, closely related speckled dace spawning may include preparation of a nest site by males (Harvey 2007). If such site preparation occurs for the closely related Umatilla dace, it implies a residence requirement for spawning and larval development. Clearly, more research is required before the issue of residence requirements can be addressed.

Scope for Management to Facilitate Recovery

Probability that Recovery Targets can be Achieved

The minimum level at which the population would be considered to have recovered is when its risk assessment status changes from Threatened to Special Concern. Umatilla dace were assessed as Threatened due to their limited total extent of occurrence in Canada (12,400 km^2), presence at only six locations, and the projected decline in area and quality of habitat (projected to decline over 50% of their range; COSEWIC 2010). First, recovery will require maintaining current abundance, distribution and number of existing locations. Second, it will require addressing the uncertainties as to the number of locations, projected rate of habitat loss, projected rate of decline in habitat quality, and quantification of threats listed within Harvey and Brown (2011). Lastly, it would require the elimination, reduction or mitigation of potential threats to habitat quality that were given as reasons for the threatened designation.

Magnitude of Each Major Potential Source of Mortality

Threat 1: Hydroelectric Development and Dams

Dam construction within the Columbia basin has been extensive, but new dams have not been built since the 1980s. Specific threats to habitat from hydroelectric operations and dam development include:

1) As Umatilla dace are considered a riverine species, the conversion of riverine habitat to reservoirs by dams (impoundment) can be considered a loss of habitat.
2) Rapid flow changes downstream of hydro facilities on the Columbia and Kootenay Rivers could strand fish along the river margins and lessen the utility of river margin habitat (COSEWIC 2010).
3) There exists the potential for independent power production (IPP) projects in a number of streams within the range of Umatilla dace (COSEWIC 2010). Some of these could require water withdrawal, which could exacerbate existing low flow conditions.

4) A proposed hydroelectric development (Shanker's' bend high dam configuration), on the U.S. side of the Similkameen River, would flood most of the known Umatilla dace habitat in the Canadian portion of the Similkameen River.

Threat 2: Alien Species

Alien invasive species are one of the greatest threats for Canadian at-risk freshwater fish and are prevalent in the Columbia River drainage. Although many of these exotics are found only in the lower Columbia River and multiple U.S. dams do limit upstream migrations, each species has the potential to be introduced above the dams and move north into the Canadian portion of the basin that is currently occupied by Umatilla dace. Currently, 14 non-native fish, as well as 1 freshwater shrimp, have been confirmed to occupy drainages within the Canadian range of Umatilla dace.

If one assumes that Umatilla dace distribution is limited to faster-flowing riverine habitats, then four species of invasive fish, currently residing within Canada, are most likely to interact with Umatilla Dace. Walleye, piscivorous northern pike, piscivorous largemouth and smallmouth bass are all found throughout Umatilla range.

Threat 3: Water extraction

Water extraction is currently not considered an issue on the Canadian portion of the mainstem Columbia, Kootenay, and Pend d'Oreille Rivers, as seasonal low flows that would normally occur in late winter to early spring (prior to snowmelt) are augmented by water stored in reservoirs. However, Umatilla dace have been sampled near the mouths of small tributaries to the Columbia, such as Beaver, Blueberry, and Champion creeks that have low seasonal water levels likely associated with water withdrawals and climatic changes. Low water levels in these tributaries could seasonally eliminate small, but possibly important, habitat sites. However, water diversion, surface water withdrawal, and groundwater extractions are considered a threat to riverine species in the Kettle River, Similkameen River and their tributaries (COSEWIC 2010).

The Similkameen and Kettle Rivers exhibit two seasonal peak flows. The first and largest peak flow occurs in June due to snowmelt. The second peak occurs in October and November and is due mainly to rain. Total annual discharge in recent years is highly variable but appears similar to historic annual volumes. Nevertheless, there have been changes to seasonal precipitation patterns, including less snowfall, earlier and quicker snowmelt, and more autumn rain. The combination of changes in seasonal precipitation and increased water withdrawals has led to extreme low flows during August and September. The majority of water withdrawals from the Similkameen River have been for irrigation and domestic consumption. Industrial use, including mining, has been small to date, but may increase in the future. When supply is limited, increasing consumptive water use requires the support of small water storage devices (i.e. higher elevation dams and ponds) that capture high melt flow in June and maintain adequate water levels through controlled releases in late summer. It appears that most of the current water licenses in the Similkameen have no real storage support.

Threat 4: Resource extraction

Threats from resource extraction include:

1) Placer mining within the Similkameen drainage could pose a threat. Although only minor production has occurred since 1900 and modern placer methods are less invasive, dace habitat could be impacted by sediments displaced from exfiltration ponds during storm events.

2) Renewed coal mining in the Tulameen River drainage. Seepage from the mines and facilities may impact water quality.

3) The Similco mine (Copper Mountain) is a large open pit mine developed at the site of previous mining operations. It lies adjacent to the east side of the Similkameen River at the confluence of Wolfe Creek. In 1979, there was a tailings spill into the river; however, only slight changes in water quality elements were noted at the time.
4) Although the Canadian portion of the Pend d'Oreille River is only 22 km long, it contains three closed mines with tailing ponds. In spite of numerous spills and the possibility of a large spill from these old tailing ponds, current water quality appears to meet provincial standards.
5) The Teck-Cominco smelter at Trail has had a history of depositing tailings and discharging waste into the Columbia River. As a result of facility upgrades, as of 1995 slag was no longer discharged into the river and most of the landfill drainage toward Stoney Creek (tributary of Columbia River) is now collected and treated. However, COSEWIC (2010) considered the possibility of a future large spill as a threat.

Threat 5: Land Use and Mountain Pine Beetle

Hélie et al. (2005), in a literature review, concluded that the current mountain pine beetle infestations in B.C. would kill enough trees to change interception and transpirations rates and induce changes in hydrology. This is especially critical for the Similkameen drainage that currently has seasonal low flows. Uunila and Pike (2006) concluded that beetle-caused deforestation would increase annual water yield, increase late summer and autumn low flows, cause earlier peak flows and produce a more variable response in peak flow magnitude. The effects of deforestation could last for 60-70 years. Salvage logging of timber infested with mountain pine beetle can increase solar radiation on streams, increase debris and runoff from road construction, increase peak stream flows through elimination of forest cover buffering on snowmelt, escalate soil erosion, and cause channel destabilization.

Threat 6: Scientific sampling

COSEWIC (2010) suggests that removal of Umatilla dace for scientific research purposes could affect the viability of some populations. The extirpation of the Otter Creek Umatilla dace population (Tulameen River) has been advanced as an example of scientific over-sampling.

Magnitude by which threats to habitat have reduced habitat quantity and quality

Most of the information on Umatilla dace in its Canadian range is limited to presence only data that suffers from very low directed sampling effort. Thus, the extent to which the species has and currently utilizes the available habitat is not known. With the limited information presently available, identifying a relationship between available habitat, threats, and abundance is impossible.

Scenarios for Mitigation and Alternative to Activities

Allowable Harm

The assessment of allowable harm to Umatilla dace in Canada is based on limited information on current abundance and conjecture on trends drawn from COSEWIC (2010). An estimation of distribution and abundance, based on verifiable metrics is required for all the systems. In view of this large uncertainty, allowable harm to Umatilla dace in all systems should include scientific sampling for the purpose of further understanding abundance and habitat use of the species, but total harm should not increase beyond current levels.

Mitigation measures

Stranding

Factors shown to influence the rate of stranding include ramping rate (rate of flow rate change), bank contour, time of day, and species behaviours. Several practical ways in which the threat of stranding could be reduced have been suggested. At present, formal stranding agreements (BC Hydro Lower Columbia and Lower Kootenay Fish Stranding Protocol) use two types of mitigation: bank re-contouring to facilitate limited pooling or runoff, and management of ramping rates. The likelihood of pool stranding might be reduced by applying a "conditioning flow reduction." A conditioning reduction is a relatively new technique in which the main reduction is preceded by a rapid, short-term one. However, tests of conditioning flows have demonstrated its viability for some species, but have not verified the efficacy of this technique for dace.

Existing treaties, agreements, and water use plans tend to limit Canada's operational flexibility to change flow regimes to address environmental concerns for a single species such as Umatilla dace. Achieving SARA compliance for existing facilities presents unique challenges for both industry and government because mitigation options are limited. Actions such as shutting down facilities or altering existing flow regimes may be technically difficult; economically unfeasible; or may run counter to an international treaty and/or other long-standing legal agreements and regulatory obligations.

Shanker's Bend

The high dam option was one of the potential threat issues considered by COSEWIC (2010) in its risk assessment. The likelihood of the Shanker's Bend high dam option must be considered low, due in part to the expected public outcry related to the flooding of 24 km of B.C bottomlands. If chosen, however, the high dam option would cause a major loss of known Umatilla dace habitat and mitigative options are not apparent. If the mid-height dam option proceeds, the Canadian portion of the Similkameen would likely lose any potential rescue effect from the downstream U.S. portion of the river because the dam would flood to the Canadian border.

Alien Invasive Species

The threat alien invasive predatory fish species pose to Umatilla dace, and it's use of habitat is likely high, but difficult to quantify. There is no way to completely eliminate established invasive fish species from large rivers like the Columbia. However, the four species (smallmouth bass, largemouth bass, northern pike and walleye) considered to be the greatest threat to small-bodied fish such as dace, are all sought-after sports fish. An increase in catch through changes in targeted recreational fisheries might reduce the numbers of these fish and should reduce predation on Umatilla dace.

In the Similkameen mainstem, continuing public awareness and enforcement might reduce the spread of invasive species. Brook trout control options introduced over the last decade, such as limiting stockings to sterile individuals in isolated lakes and through eradication or population reduction in areas where the trout have established populations, appear to have greatly reduced the impacts of brook trout on native species.

Water Extraction

The Similkameen-Boundary Area is presently attempting to resolve fish-water use conflicts resulting from seasonal over-allocation or appropriation of water. As well, the provincial Water Act is currently being re-written and it expected that changes to the new BC Water Act will improve water use criteria, compliance rates of existing licenses, and provide adequate use rate data. Ptolemy (2009) proposed storage of snowmelt water (April-June) behind small

impoundments as a way of offsetting heavier use at low flow times of year (August-September) through controlled releases. Further consideration of the annual variability in water supply could also help reduce ecosystem threats, particularly in drought years. Ptolemy (2009) proposes a "healthy flow" baseline of 20% mean annual discharge.

Scientific Sampling

Sampling protocols have been developed for at risk coastal species such as stickleback species pairs, Nooksack dace, and Salish suckers. Developing similar protocols and defensible sampling methods for Umatilla dace would require more knowledge of the species' behaviour, vulnerabilities and response to previous sampling procedures.

Forestry

Salvage logging of trees killed by mountain pine beetle may have an incidental countering effect on low flows by causing higher water tables, increased base flow, increased low flows, increasing snow pack, greater peak flows, and greater annual water yield (see Threat 4, above). It is also possible that salvage logging may increase the rate of June snow melt, increase peak flows (because flow is channelized in ditches and along roadways), and decrease the duration of snow melt. The net effect of dead forests and salvage logging on seasonal hydrographs in water-sensitive streams is complex, and it is not clear whether the seasonal low discharge would be increased.

Recovery Potential and Scenarios

Scenario 1: No further studies or actions

Even if no actions are taken prior to the next assessment, substrate habitat quality may continue to improve within the 18 km of the Columbia River below Trail as historic slag deposits relocate downstream. Although the construction of the US Shanker's Bend high dam option would have severe consequences for Umatilla dace in the Canadian portion of the Similkameen River, the likelihood of this option should be considered extremely low. For the Similkameen population, habitat area and quality may continue to decline if late summer water levels decrease due to greater water withdrawal and continued changes in regional precipitation patterns. Invasive walleye populations although currently considered stable may increase and northern pike populations are projected to increase in the mainstream Columbia River. An increase in invasive fish could reduce dace numbers through predation and might affect habitat use.

Scenario 2: Extensive survey

In order to examine the assumptions made in COSEWIC Status Report (COSEWIC 2010) a comprehensive survey is required to establish the number of existing dace locations throughout the dace range but especially in tributaries to the Similkameen River, smaller watercourses entering the main Columbia, Salmo River, reservoirs and systems above the dams, and the Kettle River below Cascade falls. Targeted surveys for Umatilla dace using standardized methods, sampling more extensively, and night sampling may increase the measured area of occupancy and number of known locations beyond the current six. This type of survey would improve our confidence in the COSEWIC designation and provide information to be used when the species is reassessed. Results from such a survey could increase the area of occupancy (currently 12,000 km^2), although it is unlikely the area can increase beyond the base line of 20,000 km^2 established by COSEWIC. An increase in the number of locations to 10 or more is more likely and could shift the status of the species toward Special Concern.

Scenario 3: Mitigate and manage threats

If the threats to Umatilla dace can be eliminated, mitigated or managed than the projected decline in habitat quality and/or habitat area associated with the various threats should not occur. Specifically, the rejection of the Shanker's Bend high dam option, thus eliminating the threat of loss of 24 km of known dace habitat loss in the Similkameen River, could be considered. The continuation of existing research and the possible introduction of new studies on life history, habitat use, and stranding are required to quantify the impact of rapid flow changes on Umatilla dace in the Columbia and Kootenay Rivers. Although numerous economic, social, international, and multi-species considerations exist, the possibility of developing reasonable criteria to minimize stranding should be examined. Modernization of the Provincial Water Act could improve water use and contribute to maintaining healthy flows. The cessation of new water licenses and improvement in small storage facilities for seasonal use could be considered. The utility of increased angling pressure on introduced alien fish species especially walleye and northern pike to reduce predation should be examined. Currently considerable social pressure exists on maintaining angling opportunities for invasive fish such as walleye, northern pike and bass both in Canada and in the US. Finally, the monitoring of water quality parameters related to resources extraction and agriculture should be continued.

Sources of Uncertainty

Various areas of uncertainty are discussed throughout the document.

SOURCES OF INFORMATION

This Science Advisory Report is from the March 14, 2011 meeting on the Recovery Potential Assessment – Umatilla Dace (*Rhinichthys umatilla*) in British Columbia. Additional publications from this process will be posted as they become available on the Fisheries and Oceans Canada Science Advisory Schedule at www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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